

MONTHLY PROGRESS REPORT Slurry/Micro-Surface Mix Design Procedure January 2004

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| TO: | T. Joe Holland, CALTRANS |
| Contract No.: | Caltrans 65A0151 |
| Agency | Fugro-BRE, Inc. |
| Prepared By: | Jim Moulthrop, Principal Investigator |
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PROJECT OVERVIEW

The overall goal of this research is to improve the performance of slurry seal and micro-surfacing systems through the development of a rational mix design procedure, guidelines, and specifications.

Phase I of the project has two major components: 1) the first consists of a literature review and a survey of industry/agencies using slurry and micro-surfacing systems, 2) the second part of Phase I deals with the development of a detailed work plan for Phases II and III.

In Phase II, the project team will evaluate existing and potential new test methods, evaluate successful constructability indicators, conduct ruggedness tests on recommended equipment and procedures, and prepare a report that summarizes all the activities undertaken under the task.

In Phase III the project team will develop guidelines and specifications, a training program, and provide expertise and oversight in the construction of pilot projects intended to validate the recommended design procedures and guidelines. All activities of the study will be documented in a Final Report.

CURRENT MONTH WORK ACTIVITIES AND COMPLETED TASKS

PHASE I—LITERATURE SEARCH AND WORK PLAN DEVELOPMENT

Task 1—Literature Review and Industry Survey

Literature Review

Completed: The literature review process is completed with all sources reviewed and summarized in Chapter 2 of the Phase I Report. The list of references is given here:

- ISSA Recommended Performance Guidelines for Slurry Seal Mix Design (A105) and Micro-Surfacing (A143)
- ASTM D3910-98 and ASTM D6372-99 Practice for Design, Testing and Construction of Slurry Seal and Micro-Surfacing respectively
- TTI Reports 0-1289-1 & 1289 2-F
- ISSA Design Technical Bulletins

- ISSA Conference Proceedings
- European Standards EN 12274-1 to 12274-8 Slurry Surfacing Test Methods Part 1 to Part 8.
- Technical Guideline: The use of Modified Bituminous Binders in Road Construction. Asphalt Academy c/o Transportek, CSIR
- Austroads – Guide to the Selection and Use of Bitumen Emulsions
- Micro-Surfacing Pilot Study 2001, Caltrans
- Ministry of Transportation, Ontario: Micro Performance Study
- Friction Evaluation of Slurry Systems in Kansas
- Pennsylvania Department of Transportation Research Report No. 89-61
- FHWA Long Term Pavement Performance (LTPP) SPS-3
- Road Trials of Stone Mastic Asphalt and Other Thin Surfacing, England
- MnROAD 1999 State Micro Surfacing Project
- City of Saskatoon, Saskatchewan, Micro-Surfacing Program

The major conclusions of the literature search are provided here:

1. In both the ISSA and ASTM design methods, it is clearly noted that the methods should only be used as a guide and that end-use specifications should be adapted to conform to job and user requirements. It is desirable to develop a more exact method that will provide successful mix designs based more, perhaps, on additional information used as input in the design method, rather than relying heavily on the experience of the construction crew with these types of treatments
2. All methods investigated are rather vague in describing the minimum number of replicate tests, the number of test specimens, and the range of conditions to be used with a specific test (e.g., range of variation in temperature, humidity, soaking time). It would be helpful to provide these details for every laboratory test used as part of the design procedure.
3. The test specimen geometry and method of preparation are different from one test to another. Ideally, to reduce variability due to specimen geometry, size, and method of preparation, all tests should use similar test specimens and several tests would be performed on the same test specimen.
4. In all tests, the aggregate particles larger than No. 4 US Sieve are scalped off. Ideally, a larger test specimen should be used to maintain the original gradation of the mix in the test specimen.
5. The repeatability of all recommended laboratory tests should be investigated.
6. The guidelines and specifications for the design of slurry seal and micro-surfacing systems are very similar and do not need to be treated separately. A unique method for the design of both slurry seal and micro-surfacing would contribute to the simplification and clarification of the design, and construction guidelines for these treatments.
7. The great majority of the existing slurry seal and micro-surfacing field projects contain information on the short-term performance of these systems, but very limited or no long-term performance data. As information from other studies (not included at this time in

the literature review) becomes available, this report will be updated to reflect the increased availability of long-term performance data.

8. Clients and agencies should be educated on the purpose, mechanisms, and options available in the frame of the preventive maintenance concept. This will help them differentiate between failure and misuse of these treatments, and will provide them with a better understanding of the project selection process.

Planned: Although the literature review process is finalized, any new sources will be reviewed as they become available.

Industry, Agency, and Advisory Panel Surveys

Completed: Following discussion with members of the team and Caltrans, three surveys were designed:

1. Agencies: Those using the AASHTO LISTSERVE link.
2. Contractors and Manufacturers: Those in the United States and the international slurry surfacing and micro-surfacing industry.
3. Advisory Panel Contractors.

The three proposed survey questionnaires were included in the August 2003 monthly report and discussed at the videoconference kickoff meeting on September 22, 2003. Based on the comments and suggestions of the participants at the videoconference, the questionnaires were revised and included in final form in the September 2003 monthly report.

New: Twenty-two responses were received from agencies, 23 from industry, and 4 from the advisory panel. The responses to the questionnaires were analyzed and the primary concerns of agencies, industry, and of the advisory panel identified. This analysis is included in the Phase I Report.

The results of the surveys were summarized in the Phase I Report and are also included here:

Agency Surveys

Of the 21 respondents, 71 percent are currently using slurry seals and/or micro-surfacing and 76 percent plan to use it in the future. The 29 percent not using these treatments either do not have experience with these materials or they have experienced past short-term failures.

Averaging agency usage generates the following numbers: 944,000 square yards of micro-surfacing were placed in 2001; 663,000 in 2002; and 717,000 in 2003. The standard deviation was about 600,000 square yards in all three years. The data on slurry seal use is very limited. According to these figures, the use of micro-surfacing did not decrease or increase; rather, it is constant at an average of nearly 700,000 square yards per year, per agency.

All those who are currently using these systems expect to continue using them in the future. The primary benefits they recognize are (in the order of frequency):

- Extended pavement life (most frequent)
- Improved skid resistance
- Cost effectiveness
- Good performance
- Rut filling (less frequent)

In regard to the observed and expected service life of slurry seals and micro-surfacing, on the average, the respondents expect service lives of three to five years for slurry seal and five to seven years for micro-surfacing. It is generally recognized that the life of the treatment is a function of traffic levels, workmanship, and the condition of the existing pavement.

Very few responses were received regarding the problems encountered with slurry seals during and after construction.

However, for micro-surfacing, various problems were identified and are listed here, in the order of frequency:

During construction:

- Workmanship (most frequent)
- Cure time related
- Control of mixing (correct amount/proportions of water, emulsion, aggregate, lime)
- Other, less frequent (traffic control, emulsion control, aggregate gradation, set time related)

After construction:

- Reflective cracking (most frequent)
- Rutting
- Raveling
- Delamination
- Wear
- Other, less frequent (potholing, bubbling surface in hot weather, flushing, snow plow blade damage)

Note that the most frequent short-term problems (during construction) are related to workmanship. Again, it appears that the skills of the construction crew are crucial to the success of the project. On the other hand, it is important to note that the most frequent long-term problems are reflective cracking and rutting, which probably are not related to the mix-design or construction process, but rather to the result of inappropriate project selection.

The last question on the agency questionnaire concerned quality assurance (QA) testing performed by the agencies. Of the 17 agencies that responded to this particular question, only 60 percent have some form of QA. The most frequent tests performed by the agencies are independent testing of the aggregate (gradation) and the emulsion prior to construction. Other more frequent tests are asphalt content and moisture. Less frequent tests include: sand equivalent test for the aggregate, placement of a test strip before construction, contractor pre-

qualification, visual acceptance in the field, warranted specification, and checking the thickness from field cores.

Note that none of the tests mentioned are performed on the mix, except for the placement of a test strip and the visual acceptance in the field. However, it would be desirable to have a field test to evaluate the mix and relate the results of this test to measures of performance.

The final comments of the agency questionnaire re-iterate some of the problems already mentioned with slurry seal and micro-surfacing and express the hope of the respondents that this study will address these problems and provide a more robust and practical design method.

Industry Surveys

Before the end of 2003, 21 industry participants and agencies responded to the industry survey. More than 76 percent of the respondents perform their own mix design for slurry seals and/or micro-surfacing. Of these, the great majority use the ISSA procedures, as they are, or with minor modifications. A limited number of respondents (3 of the 16) use the local DOT specification, and only 1 of 16 uses the ASTM methods.

Those who do not do mix designs either do not have the necessary laboratory equipment or the design is carried out by the contractor or the emulsion supplier. Very few survey participants responded to the question regarding the design method they plan to use in the future.

Of those doing their own designs, 7 of 16 use the ISSA method without any modifications. Of the remaining respondents, five use the ISSA method with minor modifications. These modifications generally add or eliminate tests from the original ISSA method according to local agency requirements. Only one respondent uses the ISSA with a major modification, using a range of conditioning methods (temperature/humidity). Two respondents did not know how different their design method was from the ISSA procedure.

When asked if there are test methods and/or procedures that need to be revised or eliminated, 43 percent of the respondents replied in the affirmative. Generally, the industry is concerned with the repeatability of all the tests and their ability to predict performance.

According to the respondents, the tests that can be related to the performance of the mix in the construction stage are the Modified Cohesion Test (ISSA TB 139) and the Trial Mix Procedure (ISSA TB 113). Other tests are mentioned but less frequently.

For tests that relate to the long term performance of the mix the survey indicates the WTAT test (ISSA TB 100) and its six-day soak variant as the best candidate. Following are the LWT test (ISSA TB 109) and the Schulze-Breuer and Ruck Procedure (ISSA TB 144). Other tests are mentioned but less frequently.

The most frequent complaints industry receives from their customers deal with the initial appearance of the surface treatment and with issues of workmanship. Other frequent complaints address the complexity of the design process, the rough surface/ride and the fact that the mix is tender in hot weather conditions.

In field operations, most frequently the respondents try to control the amount of water added to the mix. Other parameters to control include mix time, set time, good workmanship, and mix

proportions. On the other hand, industry would allow for variation in mix proportions as dictated by extreme weather conditions and changes in the aggregate source and/or emulsion type.

In their final comments, the respondents expressed their concerns with the repeatability of the current test methods and the feasibility of a new and more complex design method. They recognize the need for a test method that will take into account a range of possible environmental conditions. They also recognize their need for technical advice and the education of clients on the proper use of slurry seals and micro-surfacing.

Advisory Panel Surveys

Only the following four advisory panel members responded to this survey to date:

- Ergon A&E
- MeadWestvaco Corporation
- Pioneer Road Services Pty Ltd
- Strawser, Inc.

According to the surveys, the emulsion supplier is generally performing the design for both slurry seals and micro-surfacing. One of the four respondents uses a private testing laboratory and is also the emulsion manufacturer.

The biggest area of complaint from customers varies from one respondent to another and no common area of concern was identified for the four members of the advisory panel.

For two of four respondents, the mix designs provided to them satisfy their requirements in terms of being able to mix, place, and finish the system. The other two respondents did not answer this question.

Three of the four respondents adjust the mix design in the field. Adjustments are made to the water, filler, and emulsion contents. Generally, these adjustments are within the limits specified in the design. The primary reasons for adjusting the design are to control workability, mix time, and cure time of the mix as needed in the field.

Several difficulties in reproducing the laboratory mix design in the field were reported:

- The amount of mineral filler required is sometimes as low as 0.5 percent and some machines have a hard time providing consistent flow at this low level.
- Stockpile moisture and amount of fines in the aggregate are highly variable.
- A nighttime micro-surfacing project that was exposed to heavy traffic and rain very soon after application failed. The design did not identify the sensitivity to moisture during the transition from early rolling traffic cohesion to final cure and set.

In their final comments, the respondents identified several issues:

- The rather vague character of the current design guidelines. An example is the optimum emulsion content for which the typical design window is too wide, sometimes as wide as 6.0 percent, but usually 2.0 to 4.0 percent.
- Problems caused by the variability (ratio and quantity) of mix components in the field and changes in asphalt or aggregate sources.
- Other problems come from changes in the ratio of components in the mix or significant changes in the environmental conditions.
- The experience of the construction crew is one of the major factors affecting the success of a project.

Task 2—Work Plans for Phases II and III

Completed:

The first draft of the Phase II Work Plan has been finalized and is included in Chapter 3 of the Phase I Report. In summary, five mixes will be included in the laboratory testing factorial. The new approach is to measure the mechanical properties of the mixtures throughout the process. This is broken into construction issues and performance issues (short term and long term).

A test developed in Germany is being proposed as the method by which the mixing characteristics are measured. This will measure a profile of cohesion change during mixing allowing a mixability index and a spreadability index to be defined and specified. The apparatus consists of a special impeller mixer that is attached to a strain measurement device and a computer.

It is proposed that the short-term cohesion build be measured by an automated ISSA TB139 wet cohesion test. This will allow a traffic cohesion and early strength cohesion to be defined and specified. Both tests may be done under a range of test conditions. The apparatus is being developed.

Another cohesion type measurement is the French WTAT that uses a wheel assembly instead of a rubber hose. This test is also being developed for long term testing of abrasion resistance of cured materials.

New: The draft Phase I Report was submitted to Caltrans in the first week of February. A panel meeting is planned for February 25-26 in San Diego.

PHASE II—MIX DESIGN PROCEDURE DEVELOPMENT

Task 3—Evaluation of Potential Test Methods

No Activity

Task 4—Evaluation of Successful Constructability Indicators

No Activity

Task 5—Ruggedness Tests of Recommended Equipment and Procedures

No Activity

Task 6—Phase II Report

No Activity

PHASE III— PILOT PROJECTS AND IMPLEMENTATION

Task 7—Evaluation of Potential Test Methods

No Activity

Task 8—Workshop Training Program/Pre-Construction Module

No Activity

Task 9—Pilot Projects/Procedure Validation

No Activity

Task 10—Final Report

No Activity

NEXT MONTH'S WORK PLAN

The activities planned for next month are listed below.

- Coordinate with CALTRANS personnel on an as-needed basis.
- Present the results of the Phase I effort to Caltrans and begin Phase II.

PROBLEMS / RECOMMENDED SOLUTIONS

No problems were encountered during last month and none are anticipated next month.